NASA CR-60026

DESIGN AND DEVELOPMENT
OF A HERMETICALLY SEALED
12 AMPERE-HOUR SILVER-CADMIUM CELL
IN A NON-MAGNETIC METALLIC CASE

FINAL REPORT

CONTRACT NO. NAS 5-2155

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

YARDNEY ELECTRIC CORPORATION

NEW YORK, NEW YORK 10013

TABLE OF CONTENTS

PURPOSE

The purpose of this program was to design, develop and fabricate sealed silver-cadmium cells in non-magnetic metallic cases for tests under a satellite regime. The electrical power requirements called for a 12 ampere-hour cell to operate at 50% depth of discharge in a 100 minute cycle (charge - 65 minutes; discharge - 35 minutes).

ABSTRACT

14597

This report describes the design, development and test results of hermetically sealed silver-cadmium cells built into non-magnetic metallic containers.

The final cell design was provided with an inner plastic case and an outer non-magnetic stainless steel housing. Special welding techniques for the manufacture of the stainless container were developed to avoid introducing magnetic properties.

The cells were grouped into five batteries of thirteen cells each and cycled by Boeing Company under a simulated 300-mile orbital regime at temperatures of -10°C; 20°C and 40°C, under vacuum conditions and using a radiation heat sink. Cell failures occured at 313 to 1350 cycles. (See Boeing report, Appendix (A)). Subsequently, epoxy-potted cells of equal capacity made the same as the original YS-5-3(S) cells which gave up to 7000 cycles at 50% discharge were constructed and one battery of 12 cells and one battery of 3 cells were tested under the same orbital regime at 20°C. The 12-cell battery is still operating after over 4400 cycles. The 3-cell battery was discontinued due to a charger failure after 2371 cycles without cell failure.

INTRODUCTION

This report concerns the design, development, fabrication and test evaluation of a hermetically sealed 12 ampere hour silver-cadmium cell in a non-magnetic metallic housing.

The contract specifically required that samples of the case materials be submitted to the Goddard Space Flight Center for evaluation and approval of the non-magnetic properties prior to the construction of the cells. It further required that prototype cells be filled with sufficient helium, to determine leakage rate, and be submitted to the same agency for approval prior to final production.

All design, development and engineering was carried out by Yardney Electric Corp., New York 13, New York. The battery evaluation testing, using a simulated satellite regime, was conducted by the Boeing Company, Seattle, Washington.

MECHANICAL DESIGN AND DEVELOPMENT

A material survey was conducted to find the metal best suited for the cell container housing. The survey specifications stated that among other properties the housing material must meet three main requirements, as follows:

It must possess low magnetic properties.

It must be able to be hermetically sealed to itself and other materials with relative ease.

It must be alkali-resistant.

As a result of the material survey certain types of stainless steels were selected as most suitable for the application. However, adequate hermetic sealing and manufacturing techniques were not available and required developmental time. We therefore decided to adopt an interim design consisting of a sealed plastic cell encased in a tin coated brass housing having a soft solder seal.

The mechanical design of the cell housing was approached by dividing it into two phases. Phase I (the interim design) was concerned with the design of the tin coated brass container around the plastic cell housing. Phase II (the final design) was concerned with the development, design and construction of the stainless steel container.

Design Phase I

A total of 10 cell containers were fabricated from brass sheet, which were later tin coated to improve the soldering characteristics. The metal case covers were fabricated from tin coated brass sheet and were provided with two flanged openings to retain the ceramic ferrules for the cell terminals. All external current carrying hardware was fabricated from brass, which was silver plated and then gold flashed.

Two ceramic ferrules were used as "feed through" retainers for the extension terminals. The ceramic ferrules were metallized on their annular surfaces. The metallizing consisted of a thermally deposited molybdenum - manganese coating, with an electro-deposited layer of tin to improve the soldering characteristics.

Cell Assembly Procedure

The plastic encased cell was potted into the metal case and the metal cover was soft soldered to the case. (The metal cover was pre-assembled by feeding the extension terminals through the ceramic ferrules and soft soldering them into position). The electrical contact was provided by means of set screws which were attached to the cell terminals and the extension terminals. To provide for air expansion during soldering, an opening of 1/8 inch was provided in the center of the cover. The opening was plugged and soldered after the completion of all other soldering operations. The external surfaces of the metal container were teflon coated to provide a corrosion-resistant exterior finish.

Results of Design Phase I

The results of tests on design Phase I housing led us to the following conclusions:

1. The soft soldering of the joints under tension does not provide a reliable hermetic seal.
2. The attachment of the extension terminals by means of set screws is not reliable for good electrical contact.
3. The corrosion resistance of brass to alkali is poor and therefore the use of brass is undesirable even if the cell is first placed in a plastic container.

Design Phase II

The information obtained from tests conducted on cells constructed under design Phase I, and from the techniques developed in the sealing of stainless steel materials, led to the construction of cells under design Phase II using non-magnetic stainless steel. To achieve greater reliability in hermetic sealing the stainless steel cases had to be welded to their covers.

Sample containers constructed from type 304 stainless steel were rejected by NASA as exceeding the maximum magnetic requirements, although in the annealed condition the material is non-magnetic. The search for a stable austenitic stainless steel, which would maintain its non-magnetic properties after working and welding, led us to type 310 stainless steel. A sample container was tested by NASA and found to possess less than the maximum permissible magnetic properties. Based on these results, stainless steel type 310 was chosen as the metal container for the final cells for this program.

The ceramic ferrules were modified in shape as shown in Dwg. # 7945 Rev. B, to permit soldering to the cover and extension terminals after the cover had been welded to the case. The cell's plastic container inside the metal container, as adopted in design Phase I, was kept. The brass extension terminals were threaded to the cell terminals, eliminating the use of set screws.

The complete mechanical assembly features of this cell are shown in Dwg. No. 8007 Rev. C, and its component drawings.

The hermetic seal of each cell was tested by filling the cell with a gas mixture (85% oxygen, 15% helium) prior to sealing both the inner (plastic) and outer (metal) containers. Each cell was then tested for leakage using a mass spectrometer. All cells were found to possess a leakage rate of less than 1×10^{-6} cc per second, at a pressure differential of one atmosphere.

ELECTROCHEMICAL DESIGN AND DEVELOPMENT

Three different cell designs were constructed and evaluated for this application. The differences consisted mainly in the plate surface area and quantities of active materials. These preliminary design evaluation models were encapsulated in potting but without metal housing for ease of construction. Prior to sealing, each cell was filled with a mixture of 85% oxygen and 15% helium.

The testing of these preliminary design evaluation models was done mainly to establish capacity, and capacity maintenance during cycling under a simulated satellite regime consisting of consecutive 65-minute charge and 35-minute discharge periods. At ten cycle intervals the cells were completely discharged to obtain the full cell capacity. The capacity results for the deep discharge cycles are shown in Table I. The results show that units of cell designs I and II still performed well after 125 cycles. Cell design III reached a low capacity within 65 cycles and testing was discontinued. Cell design II was chosen as the final design to be used in this program as a result of the superior electrical performance recorded in Table I.

100 cells were then fabricated based on the mechanical design Phase II and the electrochemical cell design II, outlined previously. This cell design has been designated as Yardney Electric Corp., sealed Silcad® cell type YS12(M)S.

TABLE I

ELECTRICAL RESULTS OF THE PRELMINARY EVALUATION CELLS

TABULATION OF CAPACITIES FOR DEEP CYCLES ONLY *

Cycle No.	Cell Design I	Cell Design II		Cell Design III
		Cell #1	Cell #2	
5	12.8	13.0	12.5	11.1
10	12.3	13.2	12.4	10.5
15	12.7	-	-	9.8
20	11.6	-	-	-
30	10.6	13.7	13.1	-
40	-	13.3	12.0	8.7
50	10.0	14.1	13.7	-
60	9.2	-	-	7.5 **
70	10.4	12.3	12.5	
80	10.0	12.9	10.4	
90	8.8	13.4	13.0	
100	8.9	10.5	12.5	
110	9.1	12.5	11.9	
125	9.2	12.5	12.1	
140		13.3	13.3	
150		13.8	13.8	

NOTES:

* ALL CELLS WERE CYCLED AT THE SATELLITE REGIME OF 65-MINUTE CHARGE AND 35-MINUTE DISCHARGE. A FULL DISCHARGE CYCLE WAS APPLIED APPROXIMATELY EVERY 10 CYCLES. THE CURRENT USED FOR THE FULL CAPACITY DISCHARGE WAS 5 AMPERES TO 0.60 VOLTS PER CELL.

** CELL DESIGN III WAS STOPPED AFTER 65 CYCLES BECAUSE IT FAILED TO MEET THE SATELLITE REGIME REQUIREMENTS.

BATTERY EVALUATION TESTS

These sealed 12 ampere-hour silver-cadmium cells were grouped into batteries and were tested, evaluated and reported on by the Boeing Company, Seattle, Washington. The complete tests description, results and analysis of results are reported in Boeing Document No. D 2-20496-1, "Final Report on Evaluation of Silver-Cadmium Batteries", (Appendix A).

The results can be summarized as follows:

The cells were assembled into five (5) groups of thirteen (13) cells each and cycled as a battery under simulated 300-mile orbital conditions. They discharged 35% of their nominal ampere-hour capacity per cycle and operated in radiation heat sinks at -10°C, + 20°C and + 40°C.

The first cell failures occured at 313 cycles with others in the remaining batteries taking place at various points up to 1350 cycles. The early failures appeared to be related to leaking cells and to rapid loss in apparent capacity.

Subsequent to the early failures of these metal encased cells, two batteries of 12 AH epoxy-potted cells (12 and 3 cells respectively), manufactured and supplied by Yardney Electric Corp., were placed on test under the same cycling conditions. Those cells differed from the metal encased cells in that the separation material had been altered and the electrode surface area increased. They were scaled-up duplicates of the YS-5-3(S) which gave good performance in previous Boeing tests. The twelve-cell battery is still operating normally in a 20°C radiation heat sink after over 4400 cycles. However, a charger malfunction caused failure of the three-cell battery on a 20°C conductive heat sink, after 2371 cycles without any cell failure.

CONCLUSION

Based upon the results obtained from the two types of cells, it is evident that the design chosen for the original 12 AH cell was not satisfactory for long cycle life. This was apparently due to the desire to obtain a minimum volume cell so that higher current densities and different separator systems were used than those proven out in the original YS-5-3(S) cells which were tested by Boeing, over the last three years. The 25% discharge group are still operating after 16,700 cycles.

It is apparent that this modification caused the generation of higher gas pressures during cycling which resulted in the subsequent rupture of the plastic cells. The rupture allowed leakage to the metal case and leakage between cells, causing an unbalance which led to premature cell failure.

Tests on capacity maintenance showed there was a greater capacity loss with the new design 12 AH cell than with the original design. These are discussed in the Boeing report (Appendix A). It would appear that the combination of a different separator and higher current density caused a premature failure of these cells.

APPENDIX B

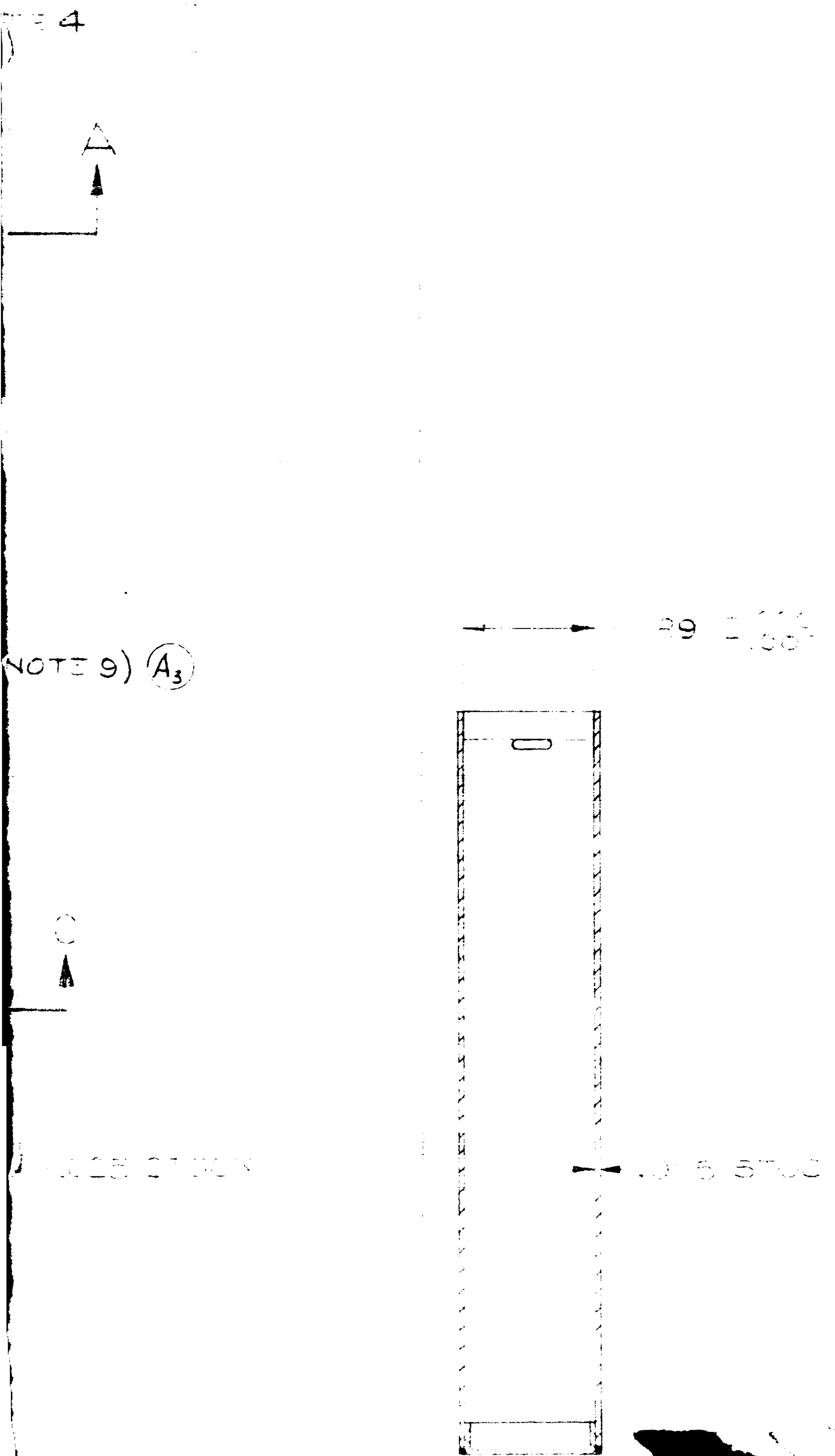
PARTS LIST FOR THE YARDNEY YS12(M)S SEALED CELL

Item II	Nomenclature	Dwg. or Part No.	Quantity per Battery
1	Metal Encased Cell Assembly YS12(M)S	YEC 8007C	1
2	Case	YEC 8013A	1
3	Cell Assembly	YEC 7952C	1
4	Cover	YEC 8014A	1
5	Ceramic Ferrule	YEC 7945B	2
6	Washer	YEC 7950B	2
7	Sockwasher	AN 935B-416L	2
8	Mex Nut	YEC 2710A-3	4
9	"Stimpson" Plug	*Stimpson No. D-3159	1
10	Spacer, Lucite .032 x 3/16 x 1/4	Commercial	8
11	Potting Compound		
	a) Epoxylite #211	Epoxylite Corp., El Monte, Calif.	35.4 g.
	b) Epoxylite Catalyst #1	"	2.3 g.
	c) Expoxylite Diluent #211-T	"	2.3 g.
12	Solder Washer, Rosin Cored 5/8 O.D. x 13/32 I.D. x .010 THK	Commerical	2

Notes: * Edwin B. Stimpson Company, 70 Franklin Avenue, Brooklyn, N.Y.

REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL
A	1) REV'D NOTES 4 & 7 2) ADDED NOTE 9 3) WAS 3/16 4) REM'D "FINISH" FROM BOTTOM WELD 5) CORR'D WELDING SYMBOLS 6) ADDED "WELDMENT" TO TITLE OF DWG. ECN°696	10-29-68	



NOTES:

1. MAT'L: STAINLESS STEEL TYPE 310, ANNEALED, .025 THK., PER QQ-S-766.
2. FINISH: ALL EXTERIOR SURFACES SHALL HAVE A FINISH EQUIVALENT TO A #3 POLISH OR BETTER.
3. MFG. STDS PER YP-197.
4. (A1) WELDING SHALL CONFORM TO SPEC. MIL-[illegible]. WELDING PROCESS SHALL BE INERT GAS [illegible] ARC USING FILLER WIRE TYPE 310 [illegible], (WHERE REQUIRED).
5. IDENTIFICATION MARKING PER YEC-928, CLASS "B" RUBBER STAMP WITH PERMANENT INK.
6. FOR COVER SEE DWG NO. 8014
7. (A1) CASE SHALL HOLD GAS PRESSURE AT 15 PSIG WITHOUT LEAKAGE. USE FIXTURE TO PREVENT CASE DISTORTION.
8. THIS PART IS USED FOR A NON-MAGNETIC APPLICATION. <u>NO</u> MATERIALS OR PROCESSES SHALL BE SUBSTITUTED OR ADDED WITHOUT PRIOR APPROVAL FROM YARDNEY ELECTRIC CORP. COLD WORKING SHALL BE KEPT TO A MINIMUM.
9. (A2) THE TWO DIMPLES SHALL STOP THE EDGE OF THE COVER FLUSH WITH THE EDGE OF THE CASE, WHEN COVER IS ASSEMBLED INTO THE CASE.

2 1

REVISIONS

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
	A	1) REVD VIEWS AND CORR'D PICTURE 2) CHG'D ASS'Y PROCEDURES NOTES AND POTTING. 3) ITEM 1 WAS PART NO 8018 CASE SUB ASS'Y 4) REVD ITEMS 5 & 10 5) ITEM 9 WAS SHIM .015 THK. ETHYL CELLULOSE 6) REMO ITEM 12 - POTTING E379 PER YP-327 7) TITLE OF DWG WAS BATTERY ASSY FOR YS12(M)S-1 ECN 698	10-30-62	CG
	B	1) ADDED NOTES 6 & 7 2) REVD NOTE 4 3) ADDED CALL-OUTS OF NOTE 6 4) REVD CALL-OUT TO CEMENT OF ITEM 9 ECN-743	11-9-62	
2C	C	1) REVD NOTE 6 2) NOTE 7 WAS 6.5 GMS. ECN-941	2-19-63	

E

D

NOTES:

1. ASSEMBLY PROCEDURES:
   a. POUR IN THE REQUIRED AMOUNT OF POTTING (ITEM 10). PLACE CELL ASSEMBLY (ITEM 2) INTO CASE (ITEM 1) ALLOWING POTTING COMPOUND TO DISTRIBUTE EQUALLY ON ALL SIDES. CELL MUST BE PLACED FIRMLY AGAINST BOTTOM OF METAL CASE.
   b. USE APPROPRIATE FIXTURE TO CENTER EXTENTION TERMINALS WITH RESPECT TO CASE AND COVER AND ALLOW TO CURE.
   c. USING EUTECTIC #157 SOLDER, PRECOAT OUTSIDE OF COVER TOP WITH A NEAT, EVEN COAT OF SOLDER. DO NOT ALLOW THE SOLDER TO RUN UP THE SIDES OF COVER.
   d. PLACE COVER INTO CASE, FLUSH WITH TOP, AND WELD ALL AROUND (GAS TIGHT) PER MIL-W-8611, TIG PROCESS. DO NOT ADD FILLER WIRE. IF FILLER WIRE IS REQUIRED TO SEAL CORNERS USE TYPE 310 ST. ST. WIRE ONLY. USE A SUITABLE HEAT SINK TO PROTECT THE SOLDER.
   e. SOLDER, ITEM 4, TO COVER AND TERMINAL USING ITEM 11 AND ADDITIONAL 60 LEAD 40 TIN, RESIN 44 CORE 66, SOLDER WIRE, AS REQUIRED DO NOT ADD ADDITIONAL FLUXES.
   f. SOLDER, ITEM 8, CLOSED USING SAME WIRE AS IN NOTE 1e.
   g. ASSEMBLE ITEMS 5, 6 AND 7 AS SHOWN.
2. MANUFACTURING STANDARDS PER YP-197.
3. TORQUE BOTTOM NUTS 10-12 INCH LBS.
4. ASSEMBLED CELL SHALL BE SUBJECTED TO A HELIUM LEAKAGE TEST AND SHALL HAVE A MAX LEAKAGE RATE OF 1×10^{-6} CC/SEC, IN A VACUUM.
5. THIS ASSEMBLY IS USED FOR A NON-MAGNETIC APPLICATION. NO MATERIALS OR PROCESSES SHALL BE SUBSTITUTED OR ADDED IN THE ASSEMBLY WITHOUT PRIOR APPROVAL FROM YARDNEY ELECTRIC CORP. ENG. DEPT.
6. MARK CHARACTERS SHOWN WITH PERMANENT BLACK INK USING SILK SCREEN OR RUBBER STAMP. COVER AREAS WITH CLEAR LACQUER.
7. MIX POTTING COMPOUND, ITEM 10, IN THE FOLLOWING

6.5 CC EPOXYLITE CATALYST #1
6.5 CC DILUENT EPOXYLITE #211-T

ITEM	REQD	PART NO.	DESCRIPTION	MATL	MATL SPEC	UNIT WT
11	2		SOLDER WASHER ROSIN CORED, 60-40 SOLDER 5/8 O.D. 3/32 I.D. x .010 THK.			
10	40 GMS		POTTING, COMPOUND DILUTED SEE NOTE 7			
9	8		SPACER, LUCITE .032 × 3/16 × 1/4			
8	1	STIMPSON NO. D-3157	"STIMPSON" PLUG	BRASS	SILVER PLATED	
7	4	2710-3	HEX NUT	BRASS		
6	2	AN935B-416L	LOCKWASHER	PHOSPHOR BRONZE	SILVER PLATE PER QQ-S-365	
5	2	7950	WASHER	NYLON		
4	2	7945	CERAMIC FERRULE			
3	1	8014	COVER			
2	1	7952	CELL ASSEMBLY			
1	1	8013	CASE			

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± 1/64 DECIMALS .X ± .XX ± .XXX ± ANGLES ±

MATL

FINISH

FINAL ASSY

D

DRAWN BY J. H. SOLIS	DATE 7-19-62
CHECKED BY	DATE 7-31-62
PROJECT ENGR	DATE
APPROVED BY	DATE

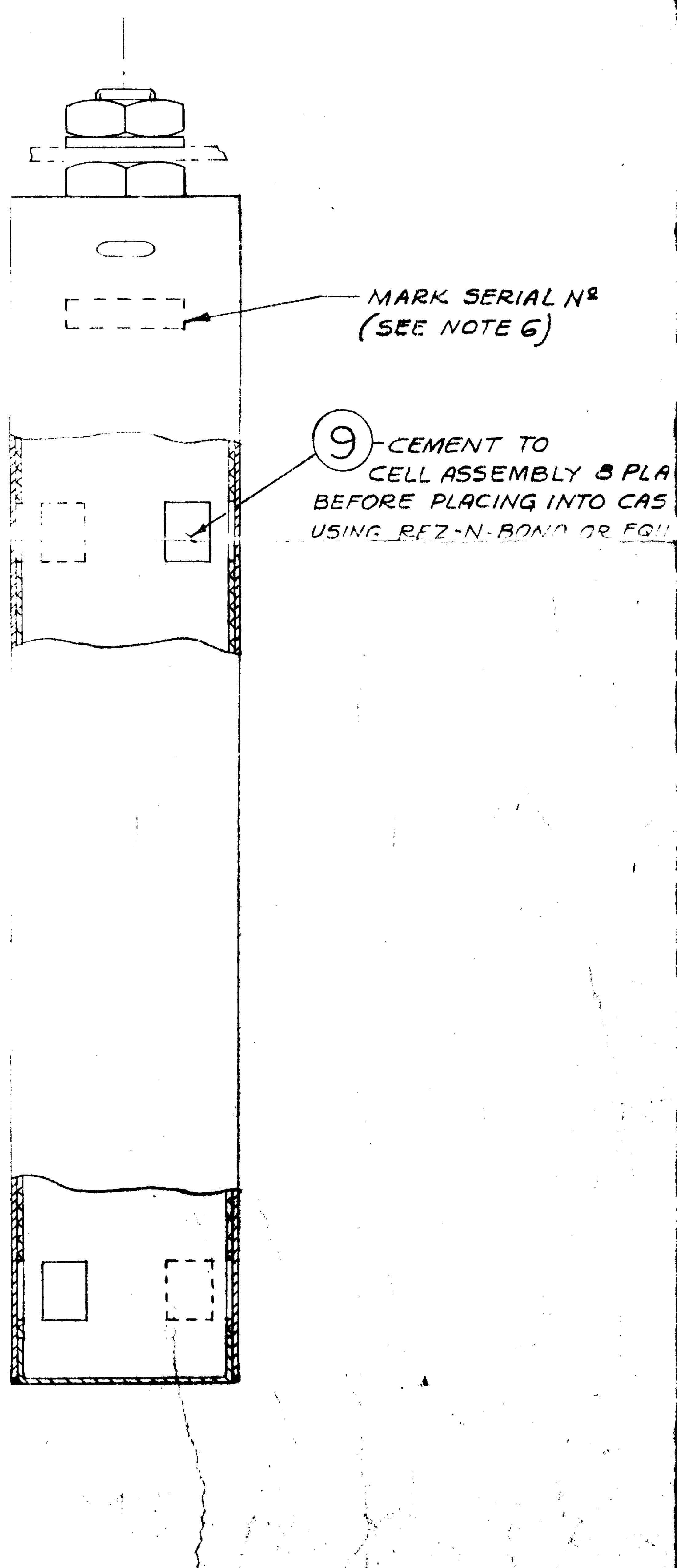
METAL ENCASED CELL ASSEMBLY YS 12 (M) S

YARDNEY ELECTRIC CORP.
NEW YORK 13, N.Y.

DWG NO. 8007 REV. C

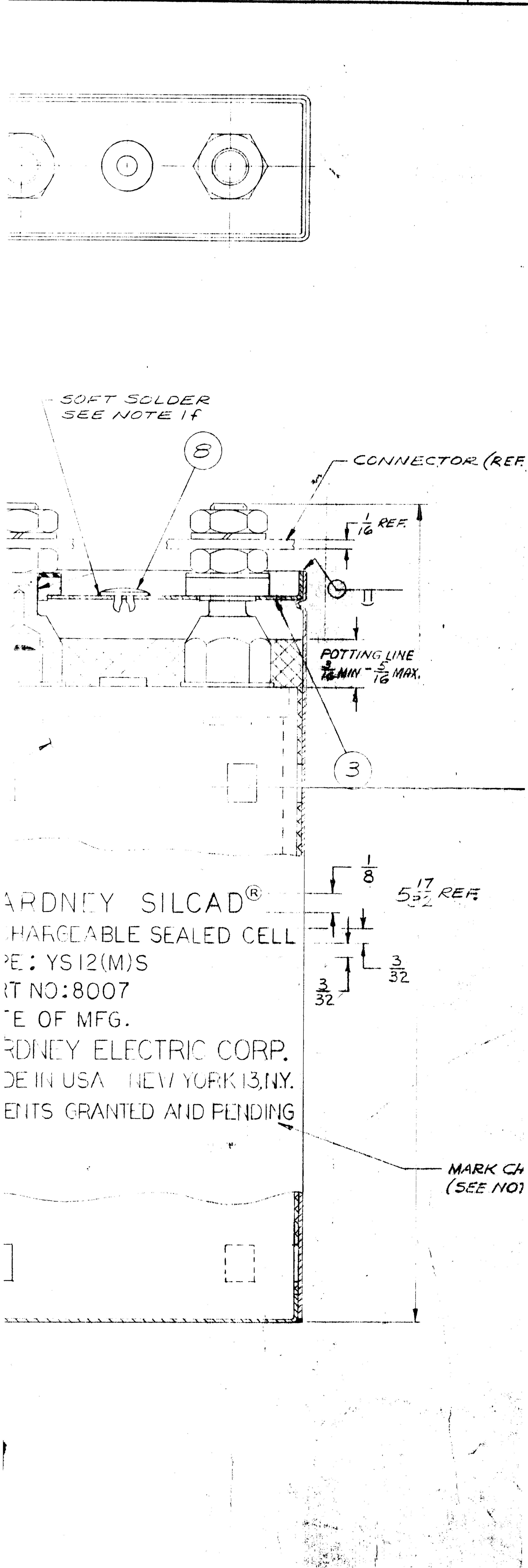
SCALE | WT CALC ACT | SHEET OF

4 | 3

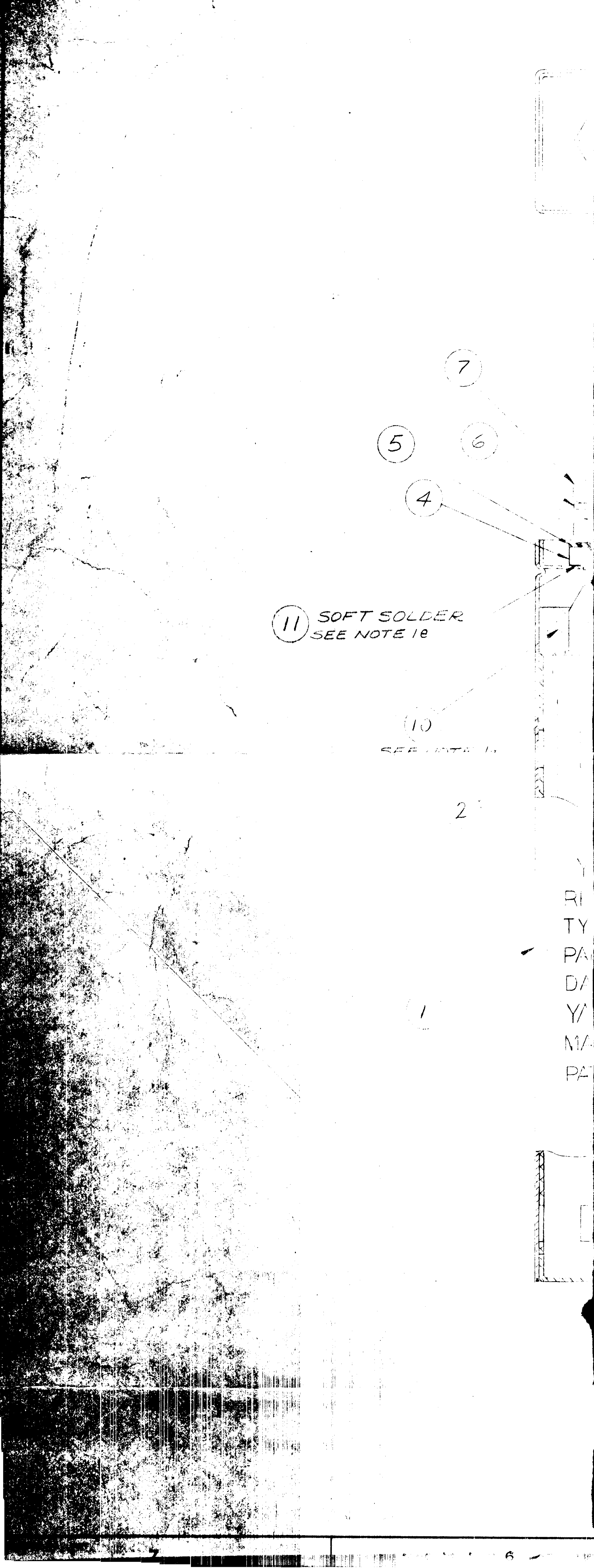


NEXT ASSY	USED ON	NEXT ASSY	FIN
APPLICATION		QTY REQ	

4 | 3



SOFT SOLDER
SEE NOTE 1f
8
CONNECTOR (REF.
1/16 REF.
II
POTTING LINE
3/16 MIN - 5/16 MAX.
3
1/8
5 17/32 REF.
3/32
3/32
ARDNEY SILCAD®
HARGEABLE SEALED CELL
PE: YS12(M)S
RT NO:8007
TE OF MFG.
RDNEY ELECTRIC CORP.
DE IN USA NEW YORK 13,N.Y.
ENTS GRANTED AND PENDING
MARK CH
(SEE NOT


7
5
6
4
11
SOFT SOLDER
SEE NOTE 18
10
2
1

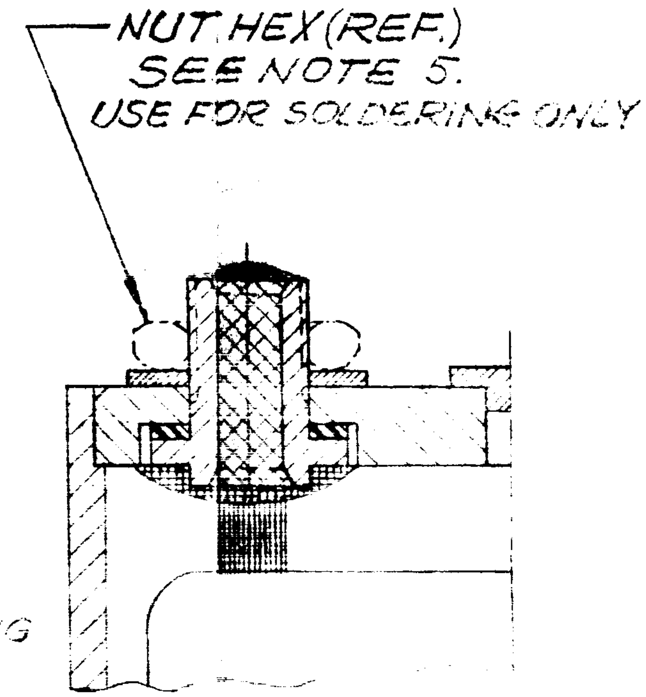
G
4.

NOTE 1

EMENT
AROUND

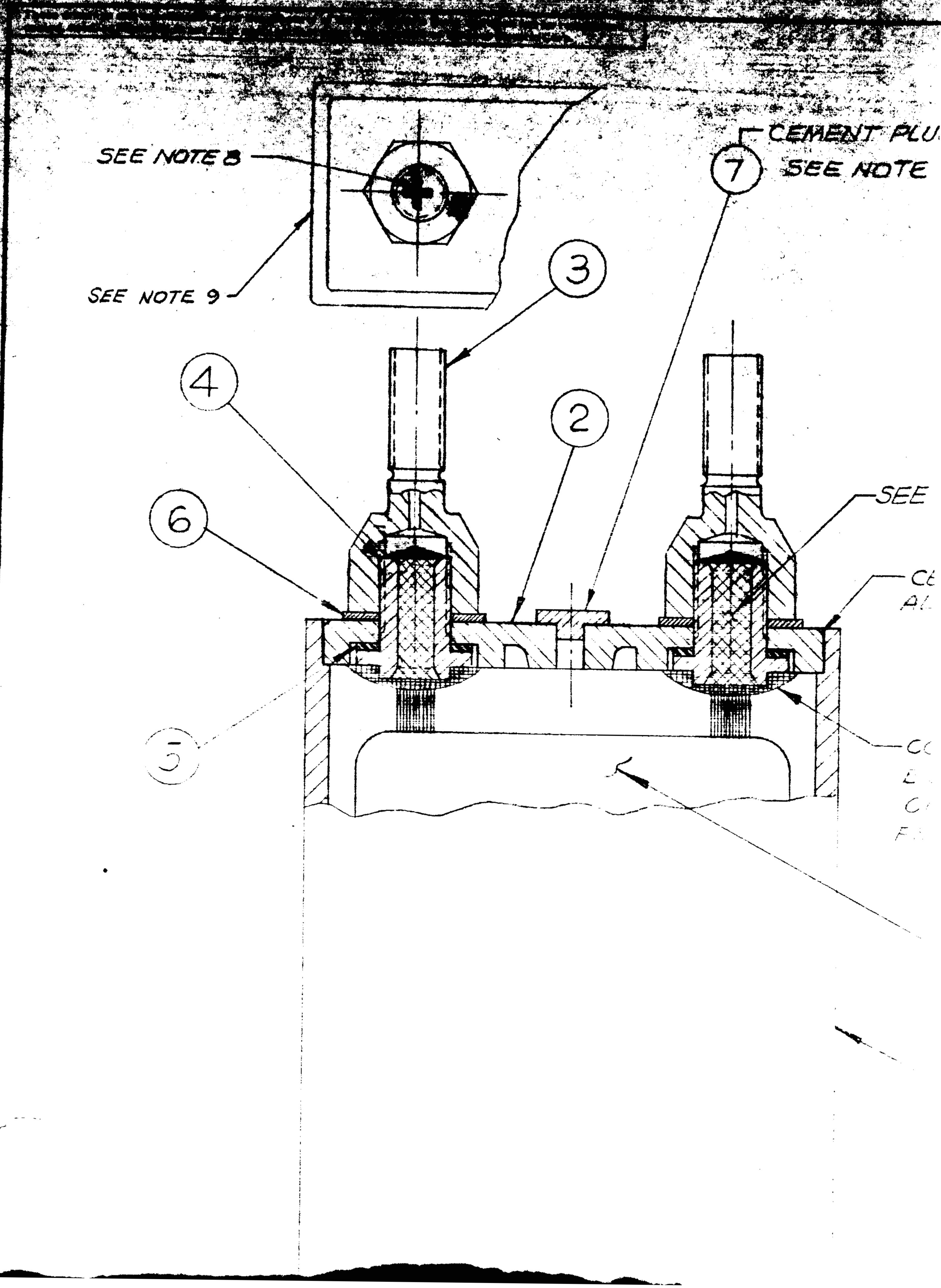
WITH
POTTING
UND

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	(1) REVISED NOTE 5. (2) ADDED: BONDMASTER VERSAMID MIXTURE. ECN-608.	9.27.62	C.G.
B	ADDED TOP VIEW & NOTE 8 ECN-697	10-29-62	C.G.
C	1) REV'D NOTE 1 2) ADDED NOTE 9 3) WAS "BONDMASTER VERSAMID MIXTURE" 4) ADDED NOTES 10 & 11 ECN-744	11-8-62	C.G.



NOTES:

1. SOLDER TERMINALS USING 60 TIN 40 LEAD ROSIN CORED SOLDER.
2. ASSEMBLE AND CEMENT COVER AS SHOWN.
3. FILL AND FORM CELL. AFTER FORMATION REMOVE EXCESS ELECTROLYTE PER APPLICABLE SPECIFICATIONS.
4. BEFORE SEALING CELL (WITH ITEM 7) VACUUM CELL TO 25" OF Hg AND FILL WITH A MIXTURE OF 85% OXYGEN AND 15% HELIUM. SEAL WITH ITEM 7 IMMEDIATELY AFTER FILLING.
5. REMOVE NUT FROM ITEM 4 AND REPLACE WITH ITEM 3. TORQUE TO 10 INCH-POUNDS.
6. CELLS, AS MANUFACTURED TO THIS DRAWING, SHALL BE FURNISHED [illegible] CONDITION.
7. [illegible] STANDARDS PER [illegible]-137
8. METAL STAMP 1/4 "PLUS" CHARACTER ON [illegible] OF POSITIVE EXTENSION TERMINAL (ITEM 5) PRIOR TO ASSEMBLY TO A [illegible] TERMINAL.
9. [illegible] OF CELL CASE [illegible]
10. USE [illegible] NUT TO HOLD TERMINALS IN PLACE DURING POTTING OF [illegible] NYLON WITH A METAL NUT [illegible] SOLDERING
11. [illegible]



SEE NOTE 8
SEE NOTE 9
CEMENT PLU
SEE NOTE
7
3
4
2
6
SEE
5

ITEM	REQD	PART NO.	DESCRIPTION	MATL	MATL SPEC	UNIT WT
8	1	YS-12S-1	CELL PACK			
7	1	7960	PLUG			
6	2	2179-3	WASHER 5/16"	BRASS		
5	2	5751	WASHER 5/16"	POLYSTYRENE		
4	2	7946	SCREW TERMINAL			
3	2	7949	EXTENSION TERMINAL			
2	1	7944	COVER OF CASE			
1	1	7943	CASE OF CELL			

LIST OF MATERIAL

APPLICATION		QTY REQD	
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
7952		1	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± DECIMALS .X ± .XX ± .XXX ± ANGLES ±

MATL

FINISH

	DATE
DRAWN BY C. VASSILIOFF	[illegible]
CHECKED BY [illegible]	[illegible]
PROJECT ENGR [illegible]	[illegible]
APPROVED BY	DATE

CELL ASSEMBLY
YS12(M)S-1

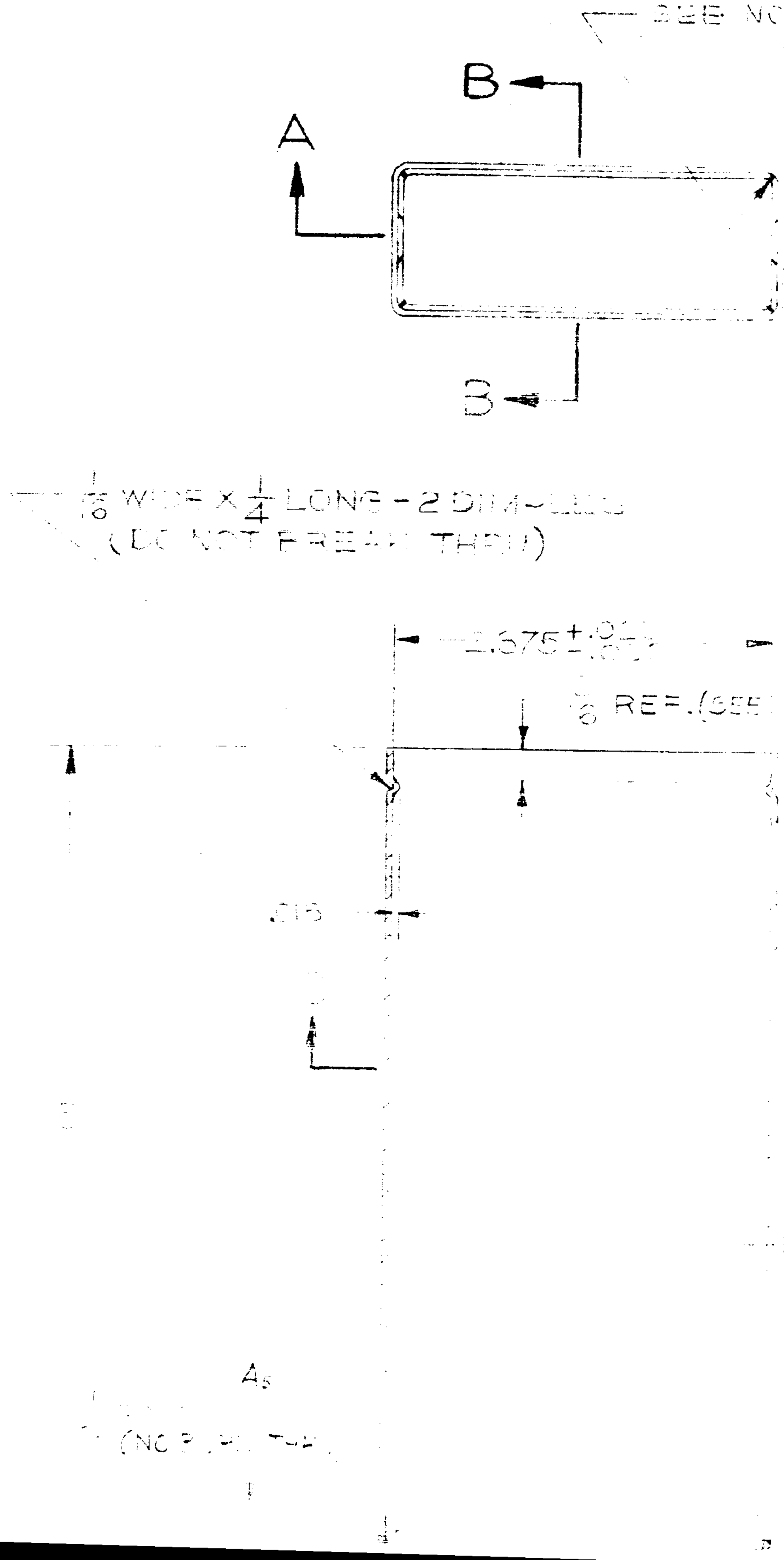
YARDNEY ELECTRIC CORP.
NEW YORK 13, N.Y.

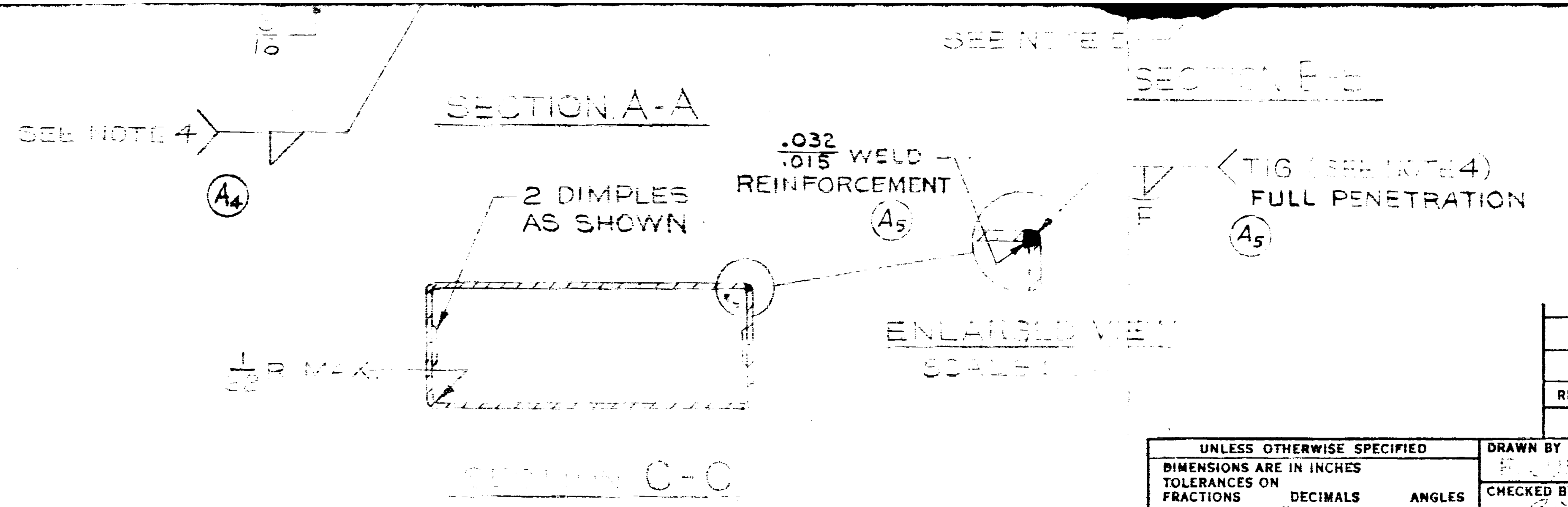
DWG NO. 7952 REV. [illegible]

SCALE [illegible] WT CALC ACT

SHEET OF

H. CO. NO. 357 28369


SEE NO
B
A
B
WIDE X 1/4 LONG - 2
(DO NOT BREAK THRU)
REF.
.015
A5



REQD	PART NO.	DESCRIPTION	MATL	MATL SPEC	UNIT WT

LIST OF MATERIAL

NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± $\frac{1}{64}$ DECIMALS .X ± .XX ± .XXX ± .005 ANGLES ± $\frac{1}{2}°$

MATL NOTED

FINISH

DRAWN BY	DATE 7-2[illegible]-62
CHECKED BY	DATE 7-30-62
PROJECT ENGR	DATE 8-2-62
APPROVED BY	DATE

CASE WELDMENT

YARDNEY ELECTRIC CORP.
NEW YORK 13, N.Y.

DWG NO. [illegible] REV. A

SCALE WT CALC ACT SHEET OF

G. B. CO., NO. 357

SYM	DESCRIPTION	DATE	APPROVAL
A	REV'D NOTES 2 & 4. ECN# 695	10-26-62	[illegible]

REVISIONS

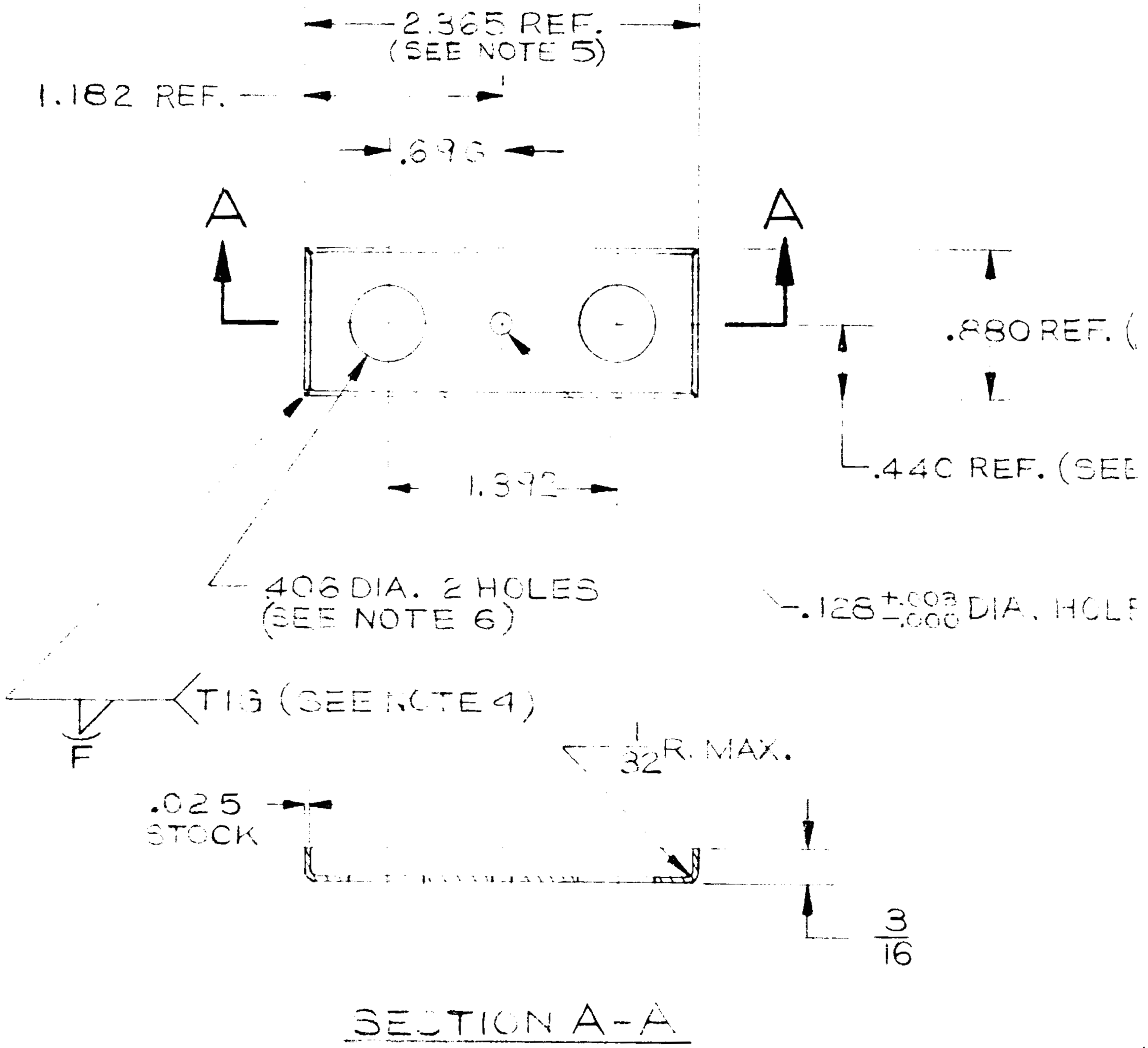
NOTES:

1. MAT'L: SST TYPE 310, ANNEALED, .025 THK. PER QQ-S-763.
2. FINISH: POLISH EXTERNAL SURFACES TO A#3 FINISH OR BETTER. (A) (SEE NOTE 5)
3. MFG. STDS PER YP-197.
4. WELDING SHALL CONFORM TO SPEC. MIL-W-8611. WELDING PROCESS SHALL BE INERT-GAS TUNGSTEN ARC USING FILLER WIRE TYPE 310 (WHERE REQUIRED). (A) (SEE NOTE 6)
5. COVER SHALL FIT INTO CASE (DWG No. 8013) WITH A TOTAL CLEARANCE OF .010 MAX. TO PERMIT WELDING TO CASE.
6. THE (2) .40[illegible] DIA. HOLES MUST BE LOCATED SYMMETRICALLY ABOUT THE TRUE CENTERLINES OF THE COVER WITH A MAXIMUM DEVIATION OF .005 FROM THE TRUE CENTERLINES.
7. THIS PART IS USED FOR NON-MAGNETIC APPLICATION. <u>NO</u> MATERIALS OR PROCESSES SHALL BE SUBSTITUTED OR ADDED WITHOUT PRIOR APPROVAL FROM YARDNEY ELECTRIC CORP. COLD WORKING SHALL BE KEPT TO A MINIMUM.

REQD	PART NO.	DESCRIPTION	MATL	MATL SPEC	UNIT WT

LIST OF MATERIAL

DRAWN BY F. JUNE	DATE 7-2[illegible]62	COVER FOR CASE (Y312(M)3-1)	YARDNEY ELECTRIC CORP. NEW YORK 13, N.Y.
CHECKED BY [illegible]	DATE 7-30-62		
PROJECT ENGR [illegible]	DATE [illegible]		DWG NO. 8014 — REV. A
APPROVED BY [illegible]	DATE [illegible]	SCALE FULL — WT CALC ACT	SHEET OF



		1	1
NEXT ASSY	USED ON	NEXT ASSY	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± $\frac{1}{64}$ DECIMALS .X ± .XX ± .XXX ± .005 ANGL

MATL NOTED

FINISH NOTED

REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL
A	1) REDRAWN 2) REV'D NOTE 1 3) ADDED NOTE 4 4) WAS .032 ±.010 5) WAS .255 /.261 DIA 6) REMD 1/16 DIM. EXTEND METALLIZING TO TOP. ECN# 549	7-31-62	
B	REMOVED NOTE "NOT PLATED" ECN# 718	11-6-62	

NOTES:

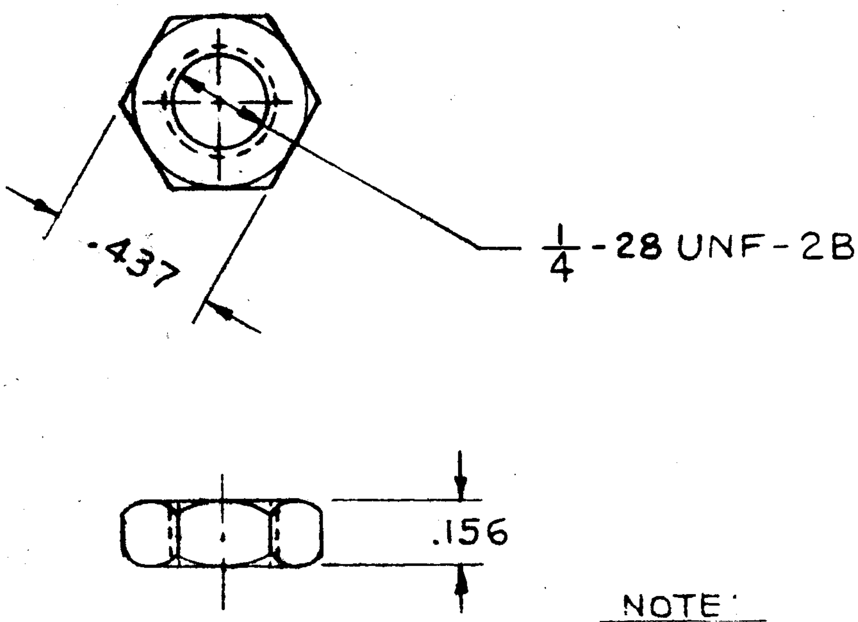
1. MATERIAL: ALUMINUM OXIDE CERAMIC, METALLIZED PER CODE L.M. AS MANUFACTURED BY CERAMIC INTERNATIONAL CORP. MAHWAH N.J. COPPER AND TIN PLATED .001 THICK. MIN.
2. HOLE SIZE AFTER METALLIZING.
3. MFG. STD'S PER YP-197
4. ALL MATERIALS SHALL BE NON-MAGNETIC.

REQD	PART NO.	DESCRIPTION	MATL	MATL SPEC	UNIT WT

LIST OF MATERIAL

DRAWN BY A. KRASSILNIKOVA	DATE 7-31-62	CERAMIC FERRULE FOR YS 12 (M) S-1 CELL	YARDNEY ELECTRIC CORP. NEW YORK 13, N.Y.
CHECKED BY	DATE		
PROJECT ENGR	DATE		
APPROVED BY	DATE		DWG NO. 7945 REV. B
		SCALE 2:1 WT CALC ACT	SHEET OF

APPLICATION		REVISIONS			
NEXT ASSY	USED ON	SYM	DESCRIPTION	DATE	APPROVAL
		A	REDRAWN ; ADDED MATL -3 WAS WASHER FACED	2-21-61	AL PK LK

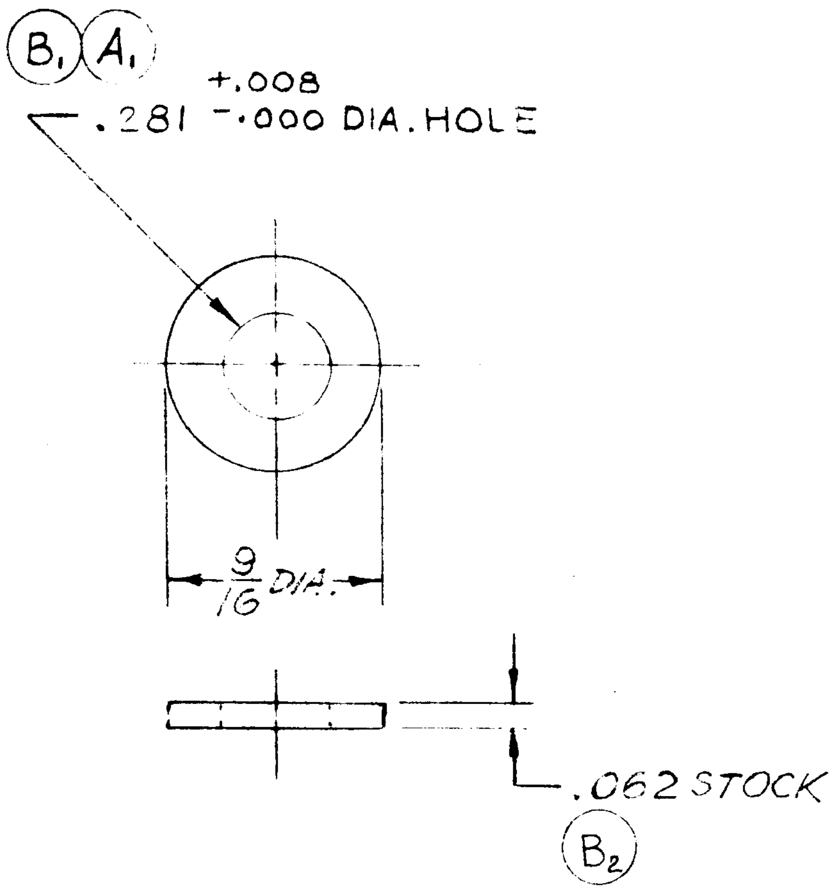


NOTE:
MFG. STDS PER YP-197

PART NO	MATERIAL	FINISH
2710	C.R.S PER QQ-S-633, FS-B1112	SILVER PLATE PER QQ-S-365, TYPE III, ($\frac{.0004}{.0002}$ THICK.)
2710-3	BRASS ROD PER QQ-B-626, COMP. 22 HARD TEMP.	GOLD PLATE PER MIL-G-14548A TYPE II, CLASS 1 (.00005 THICK) OVER SILVER PLATING PER QQ-S-365, TYPE III $\frac{.0004}{.0002}$ THICK

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: FRACTIONS $\pm\frac{1}{64}$ DECIMALS .X ± .XX ± .XXX ±.005 ANGLES ±	DRAWN BY A. KRASSILNIKOVA	DATE 2-21-61	TITLE NUT, HEX $\frac{1}{4}$-28	YARDNEY ELECTRIC CORP. NEW YORK 13, N.Y.
	CHECKED BY AL	DATE 3-1-61		
MATL NOTED	PROJ ENGR P. Karpinski	DATE 4-4-61		
FINISH NOTED	APPROVED BY AL PK LK	DATE 3-3-61		
			SCALE 2/1	DWG NO. 2710
			WT CALC	

APPLICATION		REVISIONS			
NEXT ASSY	USED ON	SYM	DESCRIPTION	DATE	APPROVAL
8007		A	WAS 1) 17/64 DIA 2) NEXT ASSY 7956(2) 3) USED ON 7956(2) FOR 561	8-3-62	
		B	WAS 1) .312 +.008 -.000 DIA. HOLE 2) .032 STOCK ECN* 694	10-26-62	CG



NOTE:

MFG. STDS. PER YP-197.

UNLESS OTHERWISE SPECIFIED	DRAWN BY	DATE	TITLE	
DIMENSIONS ARE IN INCHES TOLERANCES ON: FRACTIONS ± 1/64 DECIMALS .X ± .XX ± .XXX ±.005 ANGLES ±	C. VASSILIEFF	5-25-62	WASHER FOR YS12(M)S-1 CELL	YARDNEY ELECTRIC CORP. NEW YORK 13, N.Y.
	CHECKED BY	DATE 6-5-62		
MATL: NYLON	PROJ ENGR	DATE		
FINISH	APPROVED BY	DATE		
			SCALE 2:1	DWG No. 7950 REV. B
			WT CALC ACT	

C. B. CO., NO. 357 28714